

THE INFLUENCE OF TESTOSTERONE ON THE BEHAVIOR OF THE AUTISTIC CHILD

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Abstract. *Background* The impact of testosterone on autism symptoms is still being studied, and the precise mechanisms are not yet fully understood. **Objectives** Numerous studies have been conducted to investigate the relationship between autism and testosterone levels. The biochemical analysis of testosterone is important to perform for boys, especially for those diagnosed with autism spectrum disorders who also present a high level of aggression. **Materials and methods** While the exact causes of autism are still unknown, researchers have been studying the relationship between autism and testosterone levels in the body. It is suggested that testosterone may play a role in the higher prevalence of autism spectrum disorder to males compared to females. This has led researchers to investigate whether there is a link between autism and testosterone. **Results** Some studies have reported higher levels of testosterone in individuals with autism compared to those without autism. After analyzing the results obtained in our study, higher values of testosterone are observed in children diagnosed with ASD compared to those without ASD who form the control group, but from a statistical point of view there are no significant differences. Some researchers propose that testosterone may have an effect on certain behaviors and characteristics commonly observed in individuals with autism. Studies have shown that children with autism tend to have higher levels of testosterone in their bodies than children without autism. It is important to note that not all children with autism have high levels of testosterone, and not all children with high levels of testosterone have autism. **Conclusions** These varying results may be attributed to the heterogeneity of autism itself, as it encompasses a wide range of symptoms and characteristics. Early intervention is the key and children with autism can benefit from therapies such as speech therapy, occupational therapy and behavioral therapy. More researches are needed to fully understand the relationship between autism and testosterone.

Keywords: autism spectrum disorder, testosterone, stress

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INTRODUCTION

Exploring the complex relationship between testosterone and autism is revealing interesting insights into the characteristics and symptoms associated with autism spectrum disorders (ASD). Researches has shown that people with autism have higher testosterone levels than people without ASD. Testosterone, a hormone found primarily in men but present in both sexes, is playing a crucial role in various biological processes. Studies have shown that testosterone levels in people with autism have been often higher during prenatal development. These high levels can affect the development of certain brain structures and contribute to the manifestation of autism spectrum traits. However, not all people with autism have higher levels of testosterone, and the relationship between testosterone and autism is complex. The effects of testosterone on autism symptoms are being still under investigation, and the exact mechanisms are not being yet fully understood. However, some researchers suggest that testosterone may influence certain behaviors and characteristics that are commonly seen in people with autism.

One area of interest is the influence of testosterone on communication skills. Communication is impaired in children with ASD, and some of them never develop their verbal communication skills. Some studies suggest that higher testosterone levels may be associated with difficulties in social interaction. However, it is important to recognize that this is a complex relationship influenced by various factors and not all individuals with autism have the same patterns.

Further researches are needed to better understand the effects of testosterone on autism symptoms. Understanding the relationship between testosterone and autism spectrum traits is an ongoing area of research. By revealing the complex relationship between these factors, researchers hope to shed light on the causes of autism and possibly to develop targeted interventions to improve the lives of people with autism.

A team led by Professor Simon Baron-Cohen, Dr Michael Lombardo from the UK and Bent Nørgaard-Pedersen from Denmark analyzed 19,500 amniotic fluid samples stored in a Danish biobank from babies born between 1993 and 1999. During pregnancy, amniotic fluid is found around the baby and the samples were taken when women decide to have an amniocentesis at 15 or 16 weeks of pregnancy. This coincides with a critical period of early brain development and sexual differentiation, allowing researchers to access this window of fetal development. The researchers identified amniotic fluid samples from 128 children who were later diagnosed with autism and corroborated the data with information from the Danish Central Psychiatric Diagnostic Register. They analyzed the 4 main male sex steroid hormones in amniotic fluid: progesterone, hydroxyprogesterone, androstenedione and testosterone. They also looked at the steroid cortisol and found that high levels of steroid hormones were closely

associated with a group of children diagnosed with autism compared to a male group with normal hormone levels. According to Baron-Cohen, "it is one of the biological indicators-biomarkers that identify children who will later develop autism.

Although we know that high levels of prenatal testosterone are associated with slower social and language development, greater attention to details and some autistic traits, we now show for the first time that these steroid hormones can cause autism to male children and explains why it is more common in boys," he explained. In his opinion, these results are important because they are found in all subgroups of the autism spectrum: Asperger's syndrome, classic autism and pervasive developmental disorder not specified. However, Baron-Cohen cautions that "these results should not be considered a reason to block steroid hormones as a potential treatment, as this would cause unwanted side effects and have little or no effect on fetal steroid hormone changes." He adds that the results should also not be taken as evidence of effective prenatal detection of this syndrome. It is true that there are increasing evidences that autism begins during pregnancy (1).

Some studies have shown that people with autism have higher testosterone levels compared to people without autism, while others have found no significant differences. These varied results may be attributed to the heterogeneity of autism itself, as it encompasses a wide range of symptoms and characteristics. To better understand the possible link between autism and testosterone, the researchers have examined both prenatal and postnatal effects of testosterone. Prenatal effects of testosterone refer to the hormone's influence on fetal development, while postnatal effects refer to testosterone levels in childhood and adulthood. These studies have helped to better understand the role of testosterone in autism.

Although the etiology of ASD remains unclear, research suggests that hormonal imbalances, such as testosterone, may alter the autistic phenotype. The literature on testosterone changes during adolescence in ASD is limited (2).

Autism is usually diagnosed in early childhood, and the exact causes are still being researched. Although not a single cause is known, it is thought to be due to a combination of genetic and environmental factors. Ongoing researches aims to uncover the underlying mechanisms and factors that contribute to the development of autism. Although the exact causes of autism are still unknown, researchers have investigated the link between autism and testosterone levels in the body. Studies have shown that some children with autism have higher levels of testosterone than children without autism. This prompted researchers to investigate whether there is a link between autism and testosterone. One theory is that high levels of testosterone in the womb can affect brain development and lead to autism. Another theory is that testosterone may affect the way the brain processes information and worsen autism symptoms. Although the link between

autism and testosterone is still being researched, there are some things which parents and caregivers can do to help children with autism.

Early intervention is essential, and children with autism can benefit from therapies such as speech therapy, occupational therapy, and behavioral therapy. Additionally, there are several medications that can help manage the symptoms of autism, such as antipsychotics, antidepressants, and stimulants (3).

Although studies have shown an association between higher prenatal testosterone exposure and an increased risk of developing autism, it is important to note that correlation does not have equal causation. It is also important to recognize that not all individuals with autism identify as male or have typical male characteristics. Therefore, the assumption that all autistic people have high testosterone levels or have stereotypically "masculine" traits can be harmful and perpetuate harmful stereotypes. Finally, it is important to understand that treating high testosterone levels in children with autism can improve their symptoms (4).

It is important to note that not all children with autism have high testosterone and not all children with high testosterone have autism. More researches are needed to fully understand the link between autism and testosterone. Despite ongoing researches, there are still many misconceptions about the link between autism and testosterone. A common misconception is that all children with autism have high testosterone. However, some children with autism may have normal or even low testosterone levels.

Determination of biochemical parameters for testosterone

Testosterone is the most important male hormone, with the main action in the development of the male reproductive system, but it has a significant role in many other areas of health, both in the case of men and women.

Purpose

In this research study we wanted to see if the level of testosterone values is higher in children and youth with ASD than in neurotypical children and youth.

Due to the fact that researches in the field mention that a high level of testosterone leads to increased agitation and even the appearance of aggression in children, we considered it important to determine the value of testosterone in a group of children with ASD who presented a higher level of agitation and even aggression. We also dosed the testosterone marker in a group of neurotypical children and young people to compare the results.

Objection

1. Determination of testosterone in children and young people from the two research groups:

2. Comparison of the results obtained by the participants from the two batches.

Hypotheses

Hs1. It is assumed that there are statistically significant differences between the testosterone values of the participants in the two research groups;

Hs2. It is assumed that high testosterone levels influence the behavioral manifestations of children and youth with ASD.

MATERIAL AND METHODS

Ethics approval

In order to participate in this research, the parents of children with ASD and those in the control group have signed a consent agreement.

Study participants and protocol

Study participants - demographic data

A number of 30 children and youngs have participated in this study, 15 of whom have been diagnosed with ASD and have an increased psychomotor agitation and 15 are children and youngs without disabilities. The participants from both groups have made the testosterone analyze, analysis carried out at the Bioclinica laboratories. The children from group 1 have been diagnosed with infantile autism and severe developmental delay before the age of 3 and have started psychological and speech therapy immediately after diagnosis at the Psychological Centers in the city of Constanța. The ages of the participants in this study are between 10 and 23 years. The groups are similar in terms of age and gender and all live in Constanța.

Inclusion and exclusion criteria

Criteria for including children in the study for group 1:

- Diagnosis of ASD
- Signing the consent agreement by the parents
- Increased psychomotor agitation

Exclusion criteria:

- Absence of autism diagnosis
- Lack of psychomotor agitation
- Absence of consent agreement

Criteria for including children in the study for group 2:

- Signing the consent agreement
- Children without disabilities

Exclusion criteria:

- Presence of ASD diagnosis
- Absence of consent agreement

Data presentation and interpretation

Table no. 1. Frequency distribution for testosterone – group 1

		Testosterone			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	6.7	6.7	6.7
	4	2	13.3	13.3	20.0
	5	6	40.0	40.0	60.0
	6	1	6.7	6.7	66.7
	8	4	26.7	26.7	93.3
	9	1	6.7	6.7	100.0
	Total	15	100.0	100.0	

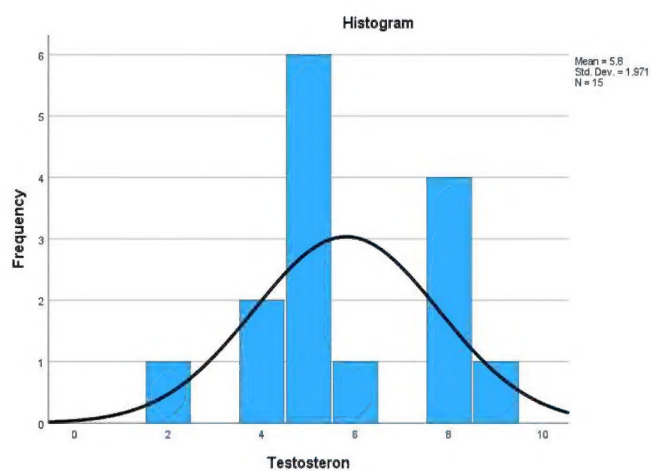


Figure no. 1. Histogram plot for testosterone – group 1

Table no. 2. Kolmogorov Smirnov and Shapiro - Wilk normality tests – group 1**Tests of Normality**

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Testosteron	.258	15	.058	.896	15	.083

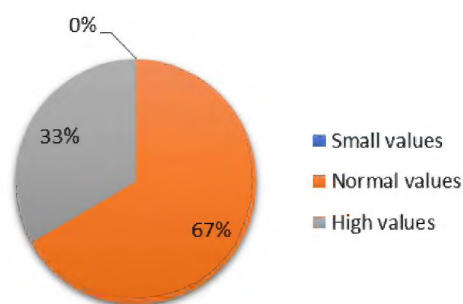
a. Lilliefors Significance Correction

After analyzing the normality test, we notice that in the Shapiro - Wilk test, which is representative for a group with few participants, we have $p = 0.083 > 0.050$, so we have a normal distribution.

Small values are marked with 1, normal values with 2 and large values with 3

Table no. 3. Frequency distribution for testosterone values - group 1

Testosterone					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	10	67.0	67.0	67.0
	3	5	33.0	33.0	100.0
	Total	15	100.0	100.0	

**Figure no. 2. Graphic representation for testosterone values – group 1**

From the image above we can see that a percentage of 67% of the participants, i.e. 10 people, had normal testosterone values, a percentage of 33% of them, i.e. 5 participants had high values and no participant had values small to that of testosterone.

Table no. 4. Frequency distribution for testosterone – group 2

Testosteron

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	20.0	20.0	20.0
	3	1	6.7	6.7	26.7
	4	5	33.3	33.3	60.0
	5	4	26.7	26.7	86.7
	6	1	6.7	6.7	93.3
	7	1	6.7	6.7	100.0
	Total	15	100.0	100.0	

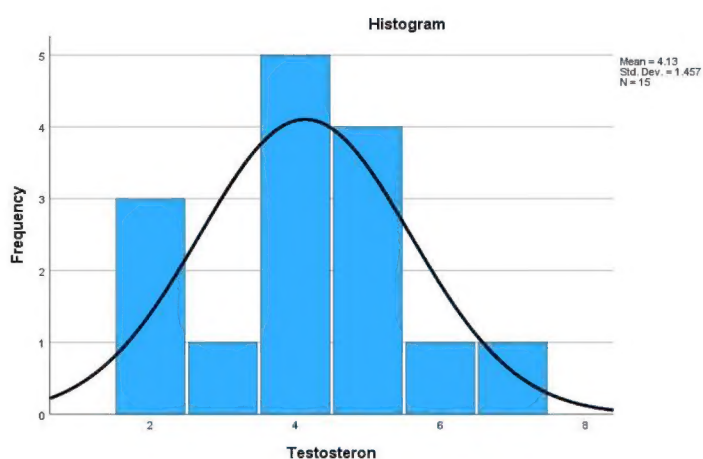


Figure no. 3. Histogram plot for testosterone - group 2

Table no. 5. Tests for normality of distribution - group 2**Tests of Normality**

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Testosterone	.197	15	.122	.925	15	.231

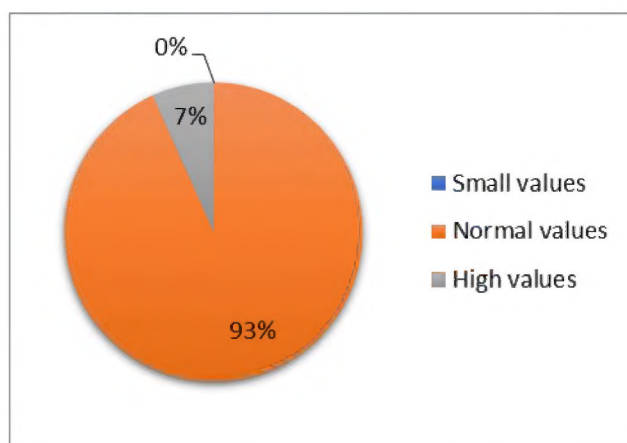
a. Lilliefors Significance Correction

From the table above it can be seen that in the Kolmogorov Smirnov test $p = 0.122 > 0.05$, so it follows that we have a normal distribution for testosterone in batch 2. The same thing can be seen in the Shapiro – Wilk test where $p = 0.231 > 0.05$.

After analyzing the normality of the distribution, we notice that for both groups we have a normal distribution and we can apply the T-test between the two groups.

Table no.6. Frequency distribution for testosterone values - group 2

Testosterone					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	14	93.3	93.3	93.3
	3	1	6.7	6.7	100.0
	Total	15	100.0	100.0	

**Figure no. 5. Graphic representation for testosterone values**

From the image above we can see that a percentage of 93 % of the participants, 14 people, had normal testosterone values, a percentage of 7% of them, 1 participant had high values and no participant had values small to that of testosterone.

Table no. 7. T-test between the two groups

Group Statistics

	Lotul	N	Mean	Std. Deviation	Std. Error
Testosterone	1	15	5.80	1.971	.509
	2	15	4.13	1.457	.376

Table no. 8. Independent Samples Test

		Independent Samples Test									
		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						One-Sided p	Two-Sided p			Lower	Upper
Testosteron	Equal variances assumed	2.253	.145	2.633	28	.007	.054	1.667	.633	.370	2.963
	Equal variances not assumed			2.633	25.784	.007	.054	1.667	.633	.365	2.968

Levene's subtest is applied to verify homogeneity of variance. Homogeneity of variance is a basic condition of the T-test. We observe that $p = 0.145 > 0.05$, so we have no statistical significance, it does not differ. It follows that the homogeneity of the variance is verified and we will read the values of T from the upper part of the table.

We note that in the T-test we have $p = 0.054 > 0.05$, so there are no statistically significant differences between the two groups. The same can be seen from the value of t , which is $2.633 > 1$. The degree of freedom $df = 30-2=28$.

CONCLUSIONS

Testosterone levels influence behavior. In the case of children with autism, a high level of this biochemical marker leads to the appearance of aggression, a fact that hinders the chances of a good school integration.

Following the statistical interpretation of the data, according to the test T result, we observe that $p = 0.054 > 0.05$, so there are no statistically significant differences between the two groups, thus not confirming hypothesis 1, named: *it is assumed that there are statistically significant differences between the testosterone values at the participants from the two research groups*.

Regarding the second hypothesis, named: *it is assumed that high testosterone values influence the behavioral manifestations of children and young people with ASD*, we note that this is confirmed because the participants in the group made up of children and young people with ASD have more pronounced symptoms.

Autism spectrum disorders, along with other neurodevelopmental disorders, are mental affections considered public health problems with significant social and economic impact. The behavioral problems of children with Autism Spectrum Disorder are the most serious that parents face. They are trying hard to find a way to understand them, to help them and especially to integrate them into their daily life activities in order to acquire skills that will be extremely useful to them in the future. Problematic behaviors such as aggression, non-conformity, self-aggression, destruction, tantrums or stereotypes are harmful to the appropriate development and school and social integration of the child.

More researches are needed to fully understand the relationship between autism and testosterone levels in both men and women. It is important not to jump to conclusions or make assumptions based on limited data, but rather to approach this topic with an open mind and a willingness to learn from new research findings.

The people in an autistic child's life who suffer the most are their own family members. From the diagnosis and acceptance to the psychological adaptation and also the adaptation to the daily life of an autistic child, the family is with him throughout his development.

These families are facing great difficulties in the education and social integration of their autistic children, as well as many other administrative and psychological comfort problems. The parents of these children are constantly looking for solutions to give them a dignified life. To be a real support for children, parents have created organizations that aim to defend and provide support to ensure the social, health and educational rights of children with autism. Life is hard, but when the autistic child recovers, the light begins to pour over these hard-pressed families. Excess of testosterone leads to increased aggressiveness, which makes school and social integration even more difficult.

Perhaps society should intervene more to support the recovery of these children through projects sponsored by the local community or through legislative intervention from the government. Together we can be useful, we can be the supporting shoulder without which everything is harder.

In the case of children, the situation is more difficult because at the time of the appearance of aggression in boys, the parents do not know which specialists to go to to solve the health problem. The family doctor should recommend blood tests and consultation with an endocrinologist. The effects of an increased level of testosterone can be very serious and the aggression that is frequently encountered greatly influences school and social integration. This can be stopped if the cause that generated the behavioral change is identified. An optimal level of testosterone can help maintain a good state of health of the body

It is extremely important to identify the level of testosterone in children with autism in order to try to reduce the severity of the symptoms and implicitly improve the state of health. The family must understand that autism is serious and many efforts must be made to improve it.

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